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(56) Documents Cited
WPI Abstract Accession No. 1994-206195[25] & JP060144898 A
WPI Abstract Accession No. 1985-022136[04] & JP590217662 A
WPI Abstract Accession No. 1984-267696[43] & JP590165615 A

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(54) Abstract Title
Production of "green" cement

(57) A hydratable cementitious composition is formed from a mixture of waste paper sludge ash and waste glass. Preferably the raw material mixture comprises 60-70 weight percent waste paper sludge ash and 30-40 weight percent waste glass. Optimum reactivity and performance are achieved when the raw materials (waste paper sludge ash and waste glass) are ground to a fine powder with particle size distribution in the range of 5-60 microns.

GB 2 362 643 A

The claims were filed later than the filing date but within the period prescribed by Rule 25(1) of the Patents Rules 1995.

PRODUCTION OF 'GREEN' CEMENT

FIELD OF THE INVENTION

The present invention relates to methods of producing 'green' or environmental cement using waste paper sludge ash and waste glass. The environamtal cement is for use in the construction industry, for example, to produce cementitious materials, such as mortar and concrete.

BACKGROUND

Portland cement has been widely used in the construction indutry to produce cementitious materials for several decades. Howevere, cementitious materials prepared using Portland cement have been observed to suffer from various forms of deterioration, subsequently leading to failure in certain harsh or aggressive environments. For instance, Portland cement products are known to suffer from sulphate attack leading to deterioration and subsequently failure in the presence of sulphates and humidity.

Furthermore, the production of Portland cement causes substantial damage to the environment due to emission or release of green house gases such as carbon dioxide. The process of Portland cement production also consume high quantities of energy. In adddition, the quarrying of the raw materials used in the production of Portland cement also contribute significantly to the damage caused to the environment.

Increase in environmental awareness over the past decade has resulted in increased legislations on the management of wastes and also in increased control on the emission levels of green house gases. Landfill sites are depleting at a fast rate. In addition, the increase in landfill costs (tax) together with increasing ressitance from communities to allow location of landfill sites near their back yard has further increase the pressure on the waste producers to find alternative methods of disposal. As a result, waste minimisation by recycling or re-used is now highly encouraged through out the world.

The application of waste materials such as ground granulated blastfurnace slag and fly ash as partial pozzolanic replacement of Portland cement has been widley used in cement and concrete technology over the past decade. This technique has resulted in a reduction in the quantity of Portland cement used in construction practice. This approach has been shown to reduce the damage cause to the environment and also the cost of construction, since Portland cement is the most expensive constituent of concrete or mortar. However, Portland cement remains a major constituent of the cementitious material containing these partial pozzolanic replacement materials. It would therfore be of great economic and environmental benefit to develope an alternative cementitious material to Portland cement solely from waste materials.

Thus the principal aim of the current invention is to develope an environmentally friendly or 'green' cementitious material from wastes materials, for use in the construction industry, for example, to produce mortar or concrete. The method provided by this invention

(W A Tasong)

provides a cementitious material which does not suffer from sulphate attack and is also several times more resistant to other noterious forms of attack such as frost attack, corrosion, etc, as is the case with Portland cement. Hence the cementitious material prepared according to this invention is suitable for application in various chemically aggressive environments such as high sulphate, freezing temperatures, etc, which Portland cement has been shown to be unsuitable. In addition the methods provided by the present invention has environmental benefits which involve avoiding the use of large quantities of quarried material or release of green house gases associated with the production of Portland cement. The production of Portland cement also requires high energy consumption. Hence, beside the savings in cost, the method provided by this invention also conserves energy.

The process of recycling paper involves the extraction of cellulose fibres from waste paper material. Large quantities of waste paper sludge consisting of a suspension of the inorganic coatings from the waste paper plus residual fibres and ink are produce as by-products of this process. The sludge is incinerated in fluidised bed system at temperatures in excess of 800 degree C to break down any dioxins. The resulting waste paper sludge ash (WPSA) have, in the past, generally been waste material with no commercial use or value, which is dumped in landfill sites at a huge cost both to the environment and the economy.

The mineralogy of a typical WPSA according to the present invention will comprise of quick lime (produce during decomposition of carbonate during incineration), metakaolin (formed during decomposition of kaolinite during incineration) and minor quantities of sulphates, calcium aluminate and calcium silicates. The chemical composition of a typical WPSA in terms of major element oxides will comprise about 20-35% CaO, 30-40% SiO_2 and 15-25% Al_2O_3. The other major element oxides such as Fe, Mg, S, etc., are also present as minor components.

The world glass industry produce several millions tonnes of waste glass annually. The UK glass industry, for example, currently produce over 2 million tonnes of glass packaging per annum. The bulk of this will be re-used in container manufacture but it is anticipated that, due to colour and other specifications, alternative uses will have to be found for over 100 thousand tonne/annum, if dumping in landfill site is to be avoided. In addition, significant quantities of waste glass is alos produced annually from demolished buildings and other related sources. The policies of most governments around the world is to seek non-landfill outlets for such waste materials.

Glass is a solid material consisting of metal silicates or similar compounds. The structure of silicate glasses is generally considered to be a three-dimensional network of randon arrangement of SiO_4 tetrahedral with at least two oxygen atoms of each tetrahedron attached to other silicon atoms. Alumino-silicate glasses include AlO_4 tetrahedron and borosilicate glasses incorporate both tetrahedral BO_4 units and triangular BO_3.

The chemical composition of a typical glass in terms of major element oxides will comprise of 35-96 weight % SiO_2, 1-5 weight % Al_2O_3, 3-10 weight % CaO, 0-15 weight % B_2O_3, 0-60 weight % PbO, 1-3 weight % R_2O_3

(W A Tasong)

and 4-20 weight % alkalis (Na + K). The other major element oxides such as Mg, Fe, etc., are also present as minor components. It should be noted that the proportions of the various major element oxide will vary, depending on the type of glass.

THE INVENTION

The present invention relates to production of 'green' or an environental cement from waste paper sludge ash and waste glass for use in the construction industry, for example, to produce cementitious materials.

According to the present invention a process of preparing a hydratble cementious composition from a mixture of waste paper sludge ash and waste glass is provided. The process generally comprises steps to process the raw materials, namely the waste paper sludge ash and the waste glass.

The waste paper sludge ash produced at the incineration stage of the paper recycling process is lumppy or coarse grained. In this state, the WPSA is inert. In order to enhance its chemical reactity, the coarse grained or lumppy WPSA is ground to a fine powder. According to the present invention, optimum reactivity is acheived for powders with a particle size distribution in the range of 5-60 microns. Similarly, the waste glass is ground to a fine powder (with a particle size distribution in the range of 5-60 microns) in order to achieve optimum chemical reactivity.

According to the present invention, a hydratable cementitious composition is formed from a mixture of waste paper sludge ash and waste glass. Preferably, the raw material mixture comprises of 60-70 weight percent waste paper sludge ash and 30-40 weight percent waste glass

According to the present invention, a chemical reaction occurs in the presence of water between the mineral phases present in waste paper sludge ash (such as metakaolin, etc.,) and the mineral phases present in the waste glass (such as borosilicate, etc.,) to form cementitious products. A chemical break down of waste paper sludge ash occurs in the presence of water. This chemical break results in the release into solution of alkalis, hydroxyl ions, etc., from the waste paper sludge ash. The alkalis and the hydroxyl ions released attack the glass, leaching further alkali metal and borate ions into solution. The leached alakli can in turn accelerate the attack on glass as well as activate the hydration process of other mineral phases also present in the mixture, such as metakaolin to release Al^{3+}, Si^{4+}, etc. ions into solution. It is proposed that a series of chemical reactions (the exact nature still to be determined) take place within the mixture to form cementitious products, such as calcium aluminate hydrates, calcium-alumino silicate hydrats, calcium silicate hydrates, calcium alumino-sulphates, etc. It is also proposed that a wide range of other cementitious compounds, whose exact nature is till to be determined are also expected to be formed from these chemical reactions.

CLAIMS

1. A green cement consists of a mixture of waste paper sludge ash and waste glass to form a hydratable cementitious composition.
2. A green cement as claimed in Claim 1 where the preferred mixture consists of 60-70 weight percent waste paper sludge ash and 30-40 weight percent waste glass.
3. A green cement as claimed in Claim 1 where the waste paper sludge ash is the residue obtained after combustion at temperatures in access of 800 degrees centigrade of the by-products (inorganic coating from waste paper plus residual fibre and ink) produced during the waste paper recycling process.
4. A green cement as claimed in Claim 1 where waste glass is glass produced by the Glass industry such as packaging glass or building glass.
5. A green cement as claimed in Claim 3 or Claim 4 where the waste paper sludge ash and waste glass are both fine powder with a particle size distribution in the range of 5-60 microns.

INVESTOR IN PEOPLE

Application No:	GB 0012952.8	**Examiner:**	Miss M M Kelman
Claims searched:	1 to 5	**Date of search:**	13 August 2001

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Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

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Other: ONLINE: CHABS, EPODOC, JAPIO, TXTE, WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	WPI Abstract Accession No. 1994-206195[25] & JP060144898 A (MITSUO) 24.05.1994 see abstract	
A	WPI Abstract Accession No. 1985-022136[04] & JP590217662 A (NODA PLYWOOD) 07.12.1984 see abstract	
A	WPI Abstract Accession No. 1984-267696[43] & JP590165615 A (FUJI FUNEN) 16.09.1984 see abstract	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.